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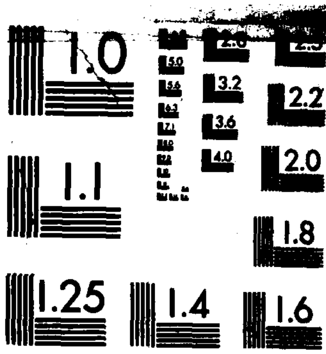

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A Comparison Of Computer-Assisted Cooperative, Competitive, And Individualistic Learning

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The effects of computer-assisted cooperative, competitive, and individualistic instruction were compared on achievement, student-student interaction, and attitudes. Seventy-four 8th-grade students were randomly assigned to conditions, stratifying for sex and ability. In all conditions students completed the same computer-assisted instructional unit. The results indicate that computer-assisted cooperative instruction promotes greater quantity and

Abstract, continued

quality of daily achievement, more successful problem solving, more task-related student-student interaction, and an increase in the perceived status of female students.

Abstract

The effects of computer-assisted cooperative, competitive, and individualistic instruction were compared on achievement, student-student interaction, and attitudes. Seventy-four 8th-grade students were randomly assigned to conditions, stratifying for sex and ability. In all conditions students completed the same computer-assisted instructional unit. The results indicate that computer-assisted cooperative instruction promotes greater quantity and quality of daily achievement, more successful problem solving, more task-related student-student interaction, and an increase in the perceived status of female students.

A Comparison Of Computer-Assisted Cooperative, Competitive, And Individualistic Learning

Computer-assisted instruction brings with it the possibility that student interaction with computers may result in less interaction with teachers and classmates. This possibility becomes enhanced when there is an individualistic assumption guiding the instructional use of computers. One student to one computer is the usual rule and computer programs have been written accordingly. The assumption that learning works best when one student works with one computer remains largely unquestioned. The possible use of computer-assisted cooperative instruction is largely ignored. The central intent of this study is to compare the relative efficacy of computer-assisted cooperative, competitive, and individualistic learning.

In a <u>cooperative</u> learning situation, students' goal achievements are positively correlated; when one student achieves his or her goal, all others with whom he or she is cooperatively linked achieve their goals (Deutsch, 1962, Johnson & Johnson, 1975). In a <u>competitive</u> learning situation, students' goal attainments are negatively correlated; when one student achieves his or her goal, all others with whom he or she is competitively linked fail to achieve their goals. In an <u>individualistic</u> learning situation, students' goal achievements are independent; the goal achievement of one student is unrelated to the achievement of others.

Each of these goal structures may be used with learning tasks involving the use of computers. To date, however, there has been almost no research comparing computer-assisted cooperative, competitive, and individualistic learning. There is a need to investigate the relative impact of computer-assisted cooperative, competitive, and individualistic learning on achievement, task-related oral interaction among students, relationships among students, and attitudes toward computers.

There is disagreement among researchers as to whether the instructional use of computers will affect students' achievement. Kulik, Bangert, and Williams (1983), for example, concluded that the use of computers raises student achievement. The research they review deals almost exclusively with computer-assisted individualistic instruction. Clark (1983), on the other hand, concluded that a computer is a vehicle that delivers instruction but does not in and of itself affect student achievement. The current evidence indicates that cooperative learning situations generally promote higher achievement than do competitive and individualistic learning situations (Johnson, Maruyama, Johnson, Nelson, & Skon, 1981). If the computer is a neutral vehicle that does not in and of itself affect student achievement (Clark, 1983), then it may be hypothesized that computer-assisted cooperative instruction will promote higher achievement than will computer-assisted competitive or individualistic instruction. If, on the other hand, the computer increased student achievement in individualistic learning situations, it may be hypothesized that computer-assisted individualistic instruction may promote higher achievement than computer-assisted competitive or cooperative instruction. The first purpose of this study is to clarify this issue.

The positive interdependence within cooperative learning situations tends to create promotive interaction among students while in competitive learning situations the negative interdependence tends to result in students obstructing each other's work (Deutsch, 1962; Johnson & Johnson, 1975, 1983). In individualistic learning situations students tend to ignore each other and avoid interaction. These interaction patterns determine the nature of communication among students. In cooperative situations communication among students tends to be frequent, open, accurate, and effective, while in competitive situations communication among students tends to be infrequent, closed, inaccurate, and ineffective (Deutsch, 1962, 1973; Johnson, 1971, 1973). In individualistic situations there tends to be no communication among students. It may be hypothesized, therefore, that when students are placed in groups of four to complete a computer-assisted instructional task, there will be (a) more statements addressed to other students, (b) more task-oriented statements, and (c) fewer social/off-task statements in the cooperative than in the competitive and individualistic conditions.

At every level, from kindergarten through graduate school, women are underrepresented in computer studies (Kolata, 1984). The gap in computer skills between males and females starts in elementary school and grows through high school. The ratio of males to females involved with computers appears to increase the more advanced, costly, and effortful the level of involvement with computers (Hess & Miura, in press; Kiesler, Sproull, & Eccles, 1983). Despite the fact that females seem to avoid computers, a number of studies have found no differences between males and females in attitudes toward learning with computers (Castleberry, Montague, & Lagowski, 1970), although females may be more apprehensive about computer-assisted instruction than males (Howe, 1971-1972). To clarify this issue three attitudes of male and female students toward computers will be measured: liking for computers, computers being a male domain, and necessity of computers for future success.

With the male domination of computer courses there is the possibility that females will be low status, undesired work partners in computer courses compared with males. In science classes males typically achieve higher and like science better (NAEP, 1979) and, therefore, males may be perceived as higher status and more desired work partners than females. On the basis of these findings it may be hypothesized that females will not be chosen as desired work partners after a computer-assisted task is completed, regardless of how the task was structured. In cooperative situations, however, past research indicated that the status of group members tends to be equalized, with all members being liked and valued (Johnson, Johnson, & Maruyama, 1983). On the basis of these findings it may be hypothesized that more females will be chosen as desired work partners after a computer-assisted cooperative than competitive or individualistic learning experience. The fourth purpose of this study is to clarify this issue.

Most of the tasks used in the previous research on the educational use of microcomputers have been drill-and-practice or programming tasks. There are fewer studies on the use of the microcomputer with problem-solving tasks. In this study, therefore, a problem-solving task is used.

Methods

Sample

Subjects were 75 8th-grade students (ages 11-13) from a midwestern, suburban, middle class school district. All subjects were randomly assigned to three conditions, stratifying for sex, handicap, and ability level. Twenty-four students were assigned to the cooperative condition (12 males and 12 females), 26 students (13 males and 13 females) were assigned to the competitive condition, and 24 students (15 males and 9 females) were assigned to the individualistic condition.

Procedure

In all three conditions students were involved in a 10-day instructional unit that paired a computer simulation with written materials on the fundamentals of map reading and navigation. The computer simulation required students to sail a ship to a new world and back in search of gold, using the sun, stars, ocean depth, climate, and trade winds to navigate. The daily instructional sessions lasted 45 minutes. Each condition was assigned a separate classroom and given access to six computers. The amount of computer time available to each student was balanced across conditions. Three certified teachers (with over 90 hours of training in how to structure cooperative, competitive, and individualistic learning) worked from prepared scripts, giving directions and supervising daily activities. Each day the teachers would explain the day's task to the students, distribute the appropriate materials, and review the condition's goal structure. At the end of the instructional session the completed work and all materials were collected. To control for possible teacher effects, the teachers rotated among conditions so that each teacher taught each condition approximately one-third of the time. Three research assistants observed student oral interaction on a daily basis in all conditions. Observers rotated so that they observed each condition an approximately equal number of times. The research assistants observed the groups in random order for 2 minutes each. The interrater reliability checks were over 80 percent (using the percentage method of agreement and disagreement for occurrence, quality, and direction).

Curriculum

A modification of a computer simulation named Geography Search (Snyder,

1982) was used in the study. The computer simulation was supplemented with written materials on the fundamentals of map reading and navigation. All students were initially trained in how to get on file with the program on the computer. The computer simulation required students to sail an ancient ship to the new world and back in search for gold, using the sun, stars, ocean depth, climate, and trade winds to navigate. The basic role of the computer was being an adjunct to (a) students' decision making and problem solving and (b) the written technical materials by providing information and giving feedback on the consequences of the actions taken. The role of the students was to master the relevant technical information and apply their knowledge in deciding what actions to take to complete successfully the problem-solving task, utilizing the computer to record their decisions and give feedback on the consequences.

Students initially had to decide whether to go ashore, follow the coast, or sail their ship. The direction the ship could sail depended on the direction of the wind. The students would have to decide whether to sail a whole day or a fraction of a day. Sailing cost the student in terms of supplies (such as food and water) and certain hazards existed such as storms and pirates. The goal of the simulation was to sail to a new continent, find the City of Gold, obtain as much gold as possible, and return to the starting point. Students had to keep track of wind direction, wind speed, their latitude and longitude, the depth of the water, food provisions, and the temperature. Each day they recorded their position on a navigational map. Because of weather conditions students may need to start over, they could starve at sea, and they could be attacked by pirates. Each class session students were given materials to read. Typical reading assignments included how to determine latitude from the position of the stars, how to determine longitude from the position of the sun, and how wind direction and speed affect sailing. After planning what to do students would go to the computer and enter their decisions, the computer would determine their results of the action taken and given additional information such as wind direction and speed and the position of the stars, the students would record the results and the information, and then the students left the computer to plan their next series of actions.

Independent Variables

The independent variables were (a) cooperative versus competitive versus individualistic learning and (b) male versus female students. In the computer-assisted cooperative learning condition students were randomly assigned to computers in groups of four (stratifying for sex and ability) and were instructed to work together as a group in completing the computer simulation task. The group's goal was to sail to the New World and back, acquiring as much gold as possible in the process. In doing so they were to ensure that all group members learned the map reading and navigational skills taught in the simulation. Students were informed that (a) they would individually complete daily worksheets and take a final test, (b) their unit grade would be based on the average of the scores of their group members on the final test and the daily worksheets, and (c) they would be awarded bonus points on the basis of how much gold the total class accumulated (10 percent of the gold all cooperative groups accumulated). Three times during the unit a subgoal was given and bonus points awarded. Subgoals included (a) how fast can your ship reach land, and (b) how fast can all the ships in the class reach land. Groups received daily feedback on hwo well they were performing.

roup members were assigned specific roles (captain, navigator, meteorologist, nd quartermaster) which were rotated among group members daily. These roles ocused on task (learning the material, recording information from computer, ompleting the work, making sailing decisions by consensus, checking members' nderstanding) and maintenance (encouraging participation by all group embers) behaviors. The role of the teacher was to structure each day's work nd monitor the learning groups to ensure that appropriate collaborative and ole behaviors were taking place.

In the computer-assisted competitive learning condition students were andomly assigned to computers in groups of four stratifying for sex and bility and were instructed to compete to see who was best. Students were nformed that they would (a) individually complete daily worksheets and take final test, (b) be graded on whether their performance was first, second, third r fourth in their group, and (c) receive bonus points if they were the first tudent in the class to complete the voyage. Three subgoals (for example, who an reach land first, who is the first to acquire gold) were given and bonus oints awarded during the unit. A class chart was used to show which students ere winning. Students were told to play fair by observing the time limits on he computer, try to be first in completing the computer search and the daily orksheets, compare their performance with that of the other students. The eacher's role was to structure each day's work and monitor the competitive roups to ensure that appropriate behavior was taking place.

In the computer-assisted individualistic learning condition students were ssigned randomly to computers in groups of four (there was one group of five) tratifying for sex and ability. Students were informed that they would (a)

Footnote

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Table 1 (page 2)

Means For Dependent Measures

	Cooperative		Competitive		Individual		
	Males	Females	Males	Females	Males	Females	F Value
Task	2.49	1.89	2.15	0.49	0.48	0.51	CCI 3.02**
Management	.33	.22	.65	.15	.14	.05	CCI 1.49 MF 2.52a
Social/Off-Task	.58	.30	.77	.99	.38	.09	CCI 1.95a
Student/Student	3.14	2.36	3.33	1.59	.85	.39	CCI 2.43*
Teacher	.25	.04	.24	.04	.16	.26	
Total Talk	3.39	2.42	3.58	1.63	1.01	.65	CCI 2.24a MF 1.60
Percent Task	.79	.82	.54	.36	.59	.76	CCI 6.17***
Percent Management	.09	.06	.23	.13	.16	.07	
Percent Social/Off-Task	.12	.12	.23	.51	.25	.71	CCI 4.29***
Percent Student/Student	.97	.98	.77	.94	.80	.50	CCI 5.69***
Percent Teacher	.03	.02	.23	.06	.20	.50	CCI 5.69***

* $P < .10$
** $P < .05$
*** $P < .01$
**** $P < .001$
a = $p < .15$

Table 1

Means For Dependent Measures

	Cooperative		Competitive		Individual		
	Males	Females	Males	Females	Males	Females	F Value
Number of Questions Completed	24.33	23.58	16.62	19.08	21.67	20.30	CCI 5.157*** MF .177
Percentage of Questions Completed	91.94	88.88	71.60	74.06	81.01	74.43	CCI 3.948** MF .186
Questions Correct (#; 5 worksheets)	4.78	5.04	3.44	4.29	3.58	4.36	CCI 3.335** MF 3.114*
Questions Correct (%; 5 worksheets)	54.04	57.76	40.54	51.23	40.26	49.00	CCI 3.050* MF 3.278*
Achievement Test	20.25	26.33	16.58	19.38	22.40	18.30	CCI 2.290* MF .630
Amount of Gold	79.25	97.00	15.23	8.69	7.00	13.56	CCI 22.717**** MF .383
Cooperative	3.67	4.22	2.50	2.00	1.80	1.33	CCI 22.289**** MF .283
Individualistic	2.42	1.89	3.17	3.75	4.27	4.33	CCI 17.707**** MF .000
Competitive	3.20	3.03	2.97	2.79	3.37	2.68	CCI .632 MF 4.010**
Liking for Computers	3.92	3.94	4.30	3.92	3.68	3.55	CCI 3.085** MF .944
Computers-Male Domain	2.02	1.13	1.84	1.62	2.19	1.39	CCI .327 MF 8.345***
Necessity of Computers	3.72	3.52	4.17	3.86	3.65	3.46	CCI 3.137** MF 2.080
Sociometric-Change Females Chosen	.30	.33	.08	.00	-.36	-.40	CCI 2.730* MF .014

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structure. Collaboration among students must be valued and supported by the overall learning environment in order for the natural tendency of students to interact around the computer to be promoted.

Students in the cooperative and the competitive conditions liked working with computers more than did the students in the individualistic condition. Students in the competitive condition perceived computers as being more necessary for success than did the students in the other two conditions. Males perceived computers as a male domain more than did females. These results provide some corroboration that cooperation promotes more positive attitudes toward the instructional experience than does individualistic work (Johnson & Johnson, 1983). Competition may enhance the view that computer skills are needed for future success (thus justifying the need to "win").

There are a number of previous studies that have indicated differences between males and females in computer courses and on tasks involving computer use. In this study females tended to make fewer comments to other students in the competitive and individualistic conditions. There were more equal participation patterns in the cooperative than in the other two conditions. There tended to be no significant differences between male and female students in performance on the task and attitudes toward computers.

This is one of the first studies to compare the effectiveness of computer-assisted cooperative, competitive, and individualistic instruction. The results imply that when teachers wish to maximize achievement on computer-assisted learning tasks, they will be well-advised to structure the lesson cooperatively rather than competitively or individualistically.

research, however, indicated that cooperative learning experiences resulted in students being perceived as being of equal status and as equally desired partners in future work situations regardless of their initial status. The desired status of females as potential future work partners increased in the cooperative condition, stayed the same in the competitive condition, and decreased in the individualistic condition. These findings support the position that cooperative learning experiences, compared with competitive and individualistic ones, equalized the status and respect for all group members.

From the early introduction of microcomputers to classrooms, teachers and researchers have noted that learning interactions where students interacted with each other differently around the computer than they did in other types of activities (Steingold, Kane, & Endreweit, 1983). When working with computers, students appeared to be interacting more with each other about learning tasks. There are anecdotal descriptions of students sharing ideas when writing stories with a computer (Rubin, 1980, 1982; Zacchei, 1982), when producing publications such as class newsletters (Collins, Bruce, & Rubin, 1982), and writing a program (Jabs, 1981). Planned observations of students working in groups at computers, however, have rarely been conducted. Hawkins, Steingold, Gearhart, and Berger (1983) did observe more collaboration among students, more solicitation of help from other students, and more "dropping in" to make comments or suggestions, in programming than in noncomputer activities in which students were permitted and/or encouraged to work together. Thus, the presence of computers may invite interaction among students. It may not be enough, however, to place students in groups while they work at the computer. The groups must have a clear cooperative goal the completion of the assigned work, while in the competitive and individualistic conditions there were significantly more social and off-task statements. In other words, when students were placed at a computer in groups of four, the way in which their learning goals were structured greatly influenced with whom students interacted and what they tended to say. Within the individualistic learning condition relatively few comments took place and many were directed at the teacher. Within the competitive condition students made a relatively high number of social/off-task comments to each other. In the cooperative condition, students engaged in relatively frequent exchange of task-related information with almost no interaction with the teacher and with few social/off-task remarks. Such oral interchange has been related to the use of higher level reasoning strategies, conceptual understanding, and long-term retention of information being learned (Johnson & Johnson, 1983). A number of researchers have concluded that the cognitive processes most necessary for deeper level understanding and the implanting of information into memory, such as elaboration and metacognition, occur only through dialogue and interaction with other people (Baker, 1979; Markman, 1979; Schallert & Kleiman, 1979). Cooperative learning promoted more of such interaction than did competitive and individualistic learning. In addition, these results support the hypothesis that promotive interaction results from a cooperative structure while an individualistic structure will tend to result in an absence of student-student interaction.

The domination by males of computer classes and the superior achievement by males typically found in science classes implies that females will be perceived of lower status and as more undesired work partners. Previous situations in promoting achievement, oral participation by male and female students, equal status between male and female students, and positive attitudes toward computers. The results of this study indicated that when computer-assisted cooperative, competitive, and individualistic learning were compared, computer-assisted cooperative learning promoted higher quantity and quality of daily achievement, more success in a complex problem-solving task involving mapping and navigation, and greater success in operating a computer program. Students in both the cooperative and the competitive conditions performed higher on an achievement test than did the students in the individualistic condition. These results corroborate and parallel the previous research comparing the relative impact of the three goal structures on students' achievement on tasks that did not require the use of the computer (Johnson, Maruyama, Johnson, Nelson, & Skon, 1981), and support Clark's (1983) conclusion that computers are vehicles that do not in themselves change the consequences of instruction. The discussion, coordination, and joint actions taken by the students in the cooperative condition promoted faster and more accurate daily work plus greater conceptual understanding of the material being learned.

The second issue addressed by this study was the target and nature of the oral participation by students while working with computers. All students were placed in groups of four, which were structured cooperatively, competitively, or individualistically. Students in the cooperative condition addressed far fewer remarks to the teacher and more remarks to each other than did the students in the competitive and individualistic conditions. The student-student interaction within the cooperative condition was almost all task-oriented, consisting of statements concerning

$p < .01$, and a lower percentage of statements to the teacher, $F(2,64) = 5.69$, $p < .01$, than did the students in the competitive and individualistic conditions. Students in the individualistic condition addressed a higher percentage of statements to the teacher than did students in the competitive condition.

The sociometric data indicated that students in the cooperative condition nominated more female classmates as desired future work partners than did the students in the competitive and individualistic conditions, $F(2,64) = 3.32$, $p < .05$ (an analysis of covariance was used to control for pre-test nominations).

Students in the cooperative condition perceived themselves as engaging in more collaborative behaviors than did the students in the other two conditions, $F(2,64) = 22.29$, $p < .01$, and students in the individualistic condition perceived themselves as engaging in more individualistic behaviors than did the students in the other two conditions, $F(2,64) = 17.71$, $p < .01$. The students in the cooperative and competitive conditions liked computers more than did the students in the individualistic condition, $F(2,64) = 3.09$, $p < .05$. Students in the competitive condition believed that computers were more necessary for future success than did the students in the cooperative and individualistic conditions, $F(2,64) = 3.14$, $p < .05$. Males perceived computers as being more of a male domain than did females, $F(2,64) = 8.35$, $p < .01$.

Discussion

The major purposes of this study were to compare the relative efficacy of computer-assisted cooperative, competitive, and individualistic learning

Results

The first dependent variable was achievement (see Table 1). Students in the cooperative condition completed more workshop items, $F(2,64) = 5.16$, $p < .01$, and correctly answered more workshop items, $F(2,64) = 3.34$, $p < .05$, than did the students in the competitive and individualistic conditions. The final examination contained three types of questions, those requiring factual recognition of material learned, those requiring the application of the material being learned, and those requiring problem solving. There were no significant differences among conditions on the test questions. The students in the cooperative condition accumulated significantly more gold than did the students in the competitive and individualistic conditions, $F(2,64) = 28.72$, $p < .01$.

The interpersonal interaction data indicated that, overall, students in the cooperative condition made 2.90 statements per minute, students in the competitive condition made 2.60 statements per minute, and students in the individualistic condition made .86 statements per minute. More task statements were made in the cooperative than in the competitive and individualistic conditions, $F(2,64) = 3.02$, $p < .05$, and students in the cooperative and competitive conditions addressed more statements to their peers than did the students in the individualistic condition, $F(2,64) = 2.43$, $p < .10$. Students in the cooperative condition made a higher percentage of task statements, $F(2,64) = 6.17$, $p < .01$, and a lower percentage of social statements, $F(2,64) = 4.29$, $p < .05$, than did the students in the competitive and individualistic conditions. Students in the cooperative condition addressed a higher percentage of statements to other students, $F(2,64) = 5.69$, support for others' learning, and indicating understanding of what is being learned. Management interactions were defined as those informing group members on procedures being used to accomplish the group's work, asking questions about group procedures, and replying. Social interactions were defined as informing group members about topics unrelated to the group's work and procedures, asking questions about such topics, and replying. This instrument has been validated in previous studies and has a reliability of over 0.90. The frequency of task, management, and social interaction was determined for each condition.

Students' perceptions of each other were measured by a sociometric nomination instrument in which students were asked to list the names of up to five classmates they would like to work with in a future cooperative group.

The attitude scales included a 12-item Liking for Computers scale (alpha = .88), a 5-item Computers Are A Male Domain scale (alpha = .84), a 6-item Necessity of Computer scale (alpha = .71), a 4-item Cooperation scale (alpha = .82), a 4-item Individualistic scale (alpha = .87), and an 8-item Competition scale (alpha = .81).

Analyses

A 3x2 ANOVA was used to analyze differences between the three conditions and males and females.

Experimental Check

Each classroom was observed daily to verify that the conditions were being taught appropriately. The results of these observations verified that the conditions were being implemented appropriately.

individually complete daily worksheets and take a final exam, (b) be graded on the basis of how their performance compared with a preset criteria of excellence, and (c) receive bonus points on the amount of gold they acquired individually. Three subgoals were presented during the unit. The subgoals included who could reach land within a certain time period and who could obtain some gold within a certain time period. Students received daily feedback in a folder available only to the individual student and the teacher. Students were told to observe the time limits on the computer, work hard to achieve up to the preset criteria of excellence, keep track of their progress, and do their own work without interacting with classmates. The teacher's role was to structure each day's work and monitor the students to ensure that appropriate behavior was taking place.

Dependent Variables

The achievement measures consisted of daily worksheets, the final examination, and the success of the students in accumulating gold. The daily worksheets tested students' comprehension of and ability to apply the reading material assigned that day. The final examination consisted of 16 multiple-choice items which measured factual recognition, application and problem solving. The test was constructed by the teachers and research staff involved in the study. Finally, the number of pounds of gold accumulated by the student was used as an index of problem-solving success.

The oral interaction measure consisted of observing students' task, management, and social interactions. Task interactions were defined as those involving repetition of information, presenting new information, elaborating on information being learned, asking task-related questions, replying, giving

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